ISSMP	INTEGRATED RESISTANCE AND AEROBIC TRAINING STUDY (SPRINT)	Sprint

Principal Investigator

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Description

Current exercise countermeasures are insufficient to prevent muscle atrophy, cardiovascular deconditioning and bone loss associated with long-duration spaceflight. A known limitation has been the inability of the ISS exercise hardware to provide sufficient loads to the human body that are required for maintaining physiological function. New flight exercise hardware, including the Advanced Resistance Exercise Device (ARED) and 2nd generation treadmill (T2) are designed to provide astronauts with the ability to exercise at higher intensity. This opens an array of new possibilities for exercise programming in long-duration spaceflight. While the ability to do resistance exercises at heavier loads and the ability to run faster and potentially with more body loading are obvious improvements in exercise capabilities, the details of how this new equipment should be used are not so obvious. Towards this end, two workshops were held, the NASA Muscle Workshop in June 2008 and the NASA International Space Station Exercise Prescription Workshop in October 2008. Intramural and extramural experts concluded that using higher intensity resistance exercises and interval aerobic exercise would help to maintain physiological function while simultaneously decreasing total exercise time and volume. Therefore, the purpose of this research is to evaluate the efficacy of a new Sprint exercise prescription designed to minimize loss of muscle, bone and cardiovascular function during ISS missions. Highlights of the Sprint exercise prescription include an increase in the intensity and a reduction in the volume of resistance exercises, inclusion of very short, but high intensity interval-type aerobic exercises, and starting the exercise countermeasures as early as possible in the flight, preferably in the first week. Pre-, in- and post-flight testing, and data sharing with selected on-going medical assessment tests, will be used to assess the effectiveness of this candidate prescription (active group) vs. normal in-flight exercise (the control group).

Objectives

To evaluate the efficacy of a new Sprint exercise prescription designed to minimize loss of muscle, bone, and cardiovascular function during ISS missions.

Relevance

Upon completion of this study, investigators expect to provide an integrated resistance and aerobic exercise training protocol capable of maintaining muscle, bone and cardiovascular health while reducing total exercise time over 180 days of spaceflight. This will provide invaluable information in support of the long-term goal of protecting human fitness for even longer space exploration missions.

BDC Summary

Subjects will be tested pre-and post-flight for a thorough analysis of muscle, bone and cardiovascular fitness. Muscle Performance Measures include: maximal strength, maximal power, power endurance, and force steadiness for upper and lower body, as well as central activation for the lower body and will be collected at L-180, L-80, L-50, R+1, R+6, and R+30. Isokinetic Testing (L-180, L-80, L-50, R+7 and R+30) will be completed via data sharing with standard medical requirement MEDB 5.3. Magnetic Resonance Imaging (MRI) scans along the entire leg to characterize spaceflight-induced change in muscle Cross-Sectional Area (CSA) will be completed at L-80, L-50, and R+1 to R+3. Ultrasound scans of the thigh and calf will be obtained on L-80, L-50, and R+0 and will be compared to the MRI results in an attempt to validate the use of Ultrasound in evaluating muscle CSA. Pre-and post-flight Maximal Aerobic Capacity (VO2max) will be evaluated on L-270, L-80, L-50, R+1, R+10, and R+30. A muscle biopsy of the thigh and calf will also be collected on L-45 and R+0 to determine: single fiber size and contractile function, single muscle fiber type identification, and biomarkers for aerobic and glycolytic enzyme markers. Muscle biopsy is optional and not required to be considered a participant in the study. Bone testing will include the current standard Dual X-ray absorptiometry (DXA) medical requirement at L<365 and <R+30 and Quantitative Computed Tomography (QCT) at the same timepoints. Crewmembers will use the ARED and T2 during their normal gym time for several weeks prior to launch to become familiar with the hardware and Sprint exercise prescription.

In-flight Operations Summary

In-flight monitoring of training loads on ARED and T2 will be evaluated as assessment of muscle function. Cardiovascular fitness will include a monthly measurement of VO2max, Heart Rate (HR) response to submaximal exercise, ventilatory threshold, Left Ventricular (LV) mass and contractility. Subjects will perform the new Sprint exercise prescription 6 days per week in-flight, beginning as early as possible, preferably on the first full in-flight day. The first 2 weeks in-flight will be an acclimation period of reduced training intensity and volume; after week 2 the full training will begin. The early onset of training is an important evidence-based aspect of the Sprint exercise prescription for prevention of the initial deconditioning that can occur in the first 30 days of unloading in the absence of any exercise program. Control subjects will consent to sharing exercise data.